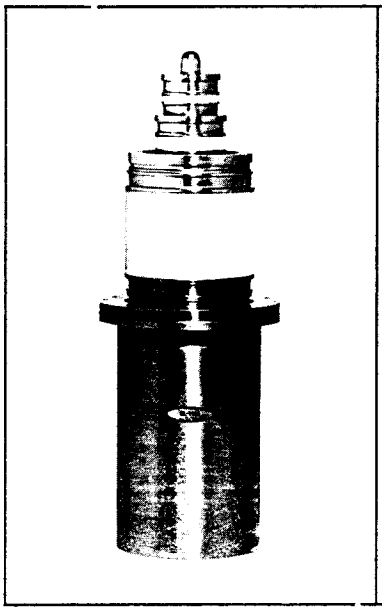
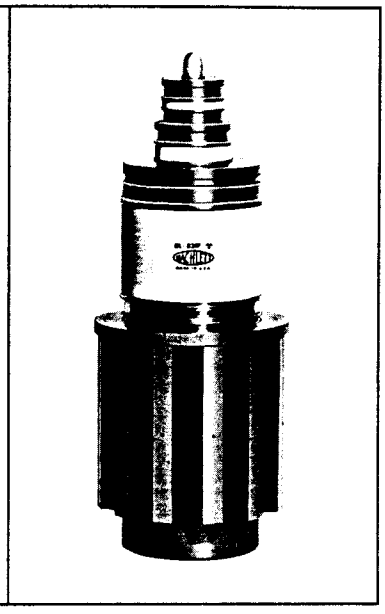
ISSUED 5-64





# ML-7560
# ML-8317

## General Purpose Triodes

440 kW CW

15 Mw Pulse Power

MACHLETT

ELECTRON TUBE SPECIALIST

## DESCRIPTION

The ML-7560 and ML-8317 are general-purpose triodes suitable for various rf and pulse applications. These tubes feature rugged coaxial mounting structures providing high-dissipation, low-inductance rf electrode terminals. The cathode of each type consists of sturdy, self-supporting, stress-free, thoriated-tungsten filaments. Envelope construction employs low-loss ceramics. The ML-7560 has a water-cooled, heavy-wall anode capable of dissipating 175 kW. The ML-8317 has a forced-air-cooled, heavy-wall anode with a high-efficiency copper fin structure capable of dissipating 60 kW. These tubes will operate with dc plate voltages up to 20 kV in CW operation or 50 kV in pulse modulator service. Maximum ratings apply at frequencies up to 30 Mc. Useful power output can be obtained at frequencies up to 110 Mc with reduced ratings.

## GENERAL CHARACTERISTICS

### Electrical

| | | |
|---|---|---|
| Filament Voltage | 14.5 | V* |
| Filament Current | 450 | A |
| Filament Starting Current, maximum | 1200 | A |
| Filament Cold Resistance | .0035 | Ohms |
| Amplification Factor | 45 | |
| Interelectrode Capacitances | | |
| Grid-Plate | 75 | pf |
| Grid-Filament | 200 | pf |
| Plate-Filament | 4 | pf |

### Mechanical

| | | |
|---|---|---|
| Mounting Position | Vertical, anode down | |
| Type of Cooling — ML-7560 | Water and forced-air | |
| Water flow on anode for 175 kW dissipation, minimum | 40 | gpm |
| Maximum outgoing water temperature | 70 | °C |
| Maximum water pressure | 80 | psi |
| Type of Cooling — ML-8317 | Forced-air | |
| Air flow on anode for 60 kW dissipation, minimum | 3000 | cfm** |
| Maximum incoming air temperature | 50 | °C |
| Air Flow on Insulators and Seals, approximate | 500 | cfm*** |
| Maximum Ceramic Temperature | 165 | °C |
| Net Weight, approximate | | |
| ML-7560 | 110 | lb |
| ML-8317 | 130 | lb |

*For cathode currents in excess of 350 amps, filament voltage must be 15.0 volts. For older tubes with serial numbers lower than 476,000, the filament must be operated at 16.5 volts for peak cathode currents up to 350 amps.

**When used with ML-8317 air distributor F-27836.

***At frequencies up to 15 Mc, air flow should be directed primarily on the filament seals and main ceramic insulator; at higher frequencies or high ambient temperatures, additional air flow may be required on the grid seals. Air flow should be distributed to maintain uniform temperature, not greater than 165°C, around the circumference of the seals.

## MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

(Continuous Commercial Service)

VALUES APPLY TO BOTH TYPES UNLESS OTHERWISE SPECIFIED

### Audio-Frequency Power Amplifier and Modulator Class B

| Maximum Ratings, Absolute Values | ML-7560 | ML-8317 | |
|---|---|---|---|
| DC Plate Voltage | 20000 | 20000 | V |
| Max.-Signal DC Plate Current▲ | 30 | 20 | A |
| Plate Dissipation▲ | 175 | 60 | kW |

| Typical Operation (Values are for two tubes) | ML-7560 | | |
|---|---|---|---|
| DC Plate Voltage | 15000 | 15000 | V |
| DC Grid Voltage | −320 | −320 | V |
| Peak AF Grid-to-Grid Voltage | 1740 | 1080 | v |
| Peak AF Plate-to-Plate Voltage | 25200 | 26000 | v |
| Zero-Signal DC Plate Current | 2 | 2 | A |
| Max.-Signal DC Plate Current | 56 | 23 | A |
| Effective Load Resistance, Plate-to-Plate | 570 | 1400 | ohms |
| Max.-Signal Driving Power, approximate | 5 | 1.1 | kW |
| Max.-Signal Power Output, approximate | 550 | 240 | kW |

### Linear RF Power Amplifier — Class AB Single-Sideband Suppressed-Carrier Service

| Maximum Ratings, Absolute Values | ML-7560 | ML-8317 | |
|---|---|---|---|
| DC Plate Voltage | 20000 | 20000 | V |
| Grid Dissipation | 2500 | 2500 | W |
| Plate Dissipation | 175 | 60 | kW |

| Typical Operation, Cathode-Drive, 2-tone | ML-7560 | | |
|---|---|---|---|
| DC Plate Voltage | 20000 | 20000 | V |
| DC Grid Voltage | −450 | −450 | V |
| Zero-Signal DC Plate Current | 1 | 1 | A |
| Maximum-Signal Peak Plate Current | 54 | 27 | a |
| Maximum-Signal Peak RF Grid Voltage | 690 | 580 | v |
| Maximum-Signal Driving Power | 10 | 4 | kW |
| Peak Envelope Power Output ‡ | 230 | 114 | kW |
| Average Power Output, approximate | 115 | 57 | kW |

| Typical Operation Cathode-Drive, 16-tone† | |
|---|---|
| DC Plate Voltage | 20000 V |
| DC Grid Voltage | −450 V |
| Zero-Signal DC Plate Current | 1 A |
| Maximum-Signal Peak Plate Current | 135 a |
| Maximum-Signal Peak RF Grid Voltage | 1100 v |
| Maximum-Signal Peak Driving Power | 41 kw |
| Peak Envelope Power Output ‡ | 585 kw |
| Average Power Output, approximate | 58 kW |

### Plate-Modulated RF Power Amplifier Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

| Maximum Ratings, Absolute Values | ML-7560 | ML-8317 | |
|---|---|---|---|
| DC Plate Voltage | 15000 | 15000 | V |
| DC Grid Voltage | −1500 | −1500 | V |
| DC Plate Current | 20 | 15 | A |
| DC Grid Current | 4.0 | 3 | A |
| Plate Dissipation | 115 | 40 | kW |

| Typical Operation | ML-7560 | |
|---|---|---|
| DC Plate Voltage | 14000 | V |
| DC Grid Voltage | −1000 | V |
| Peak RF Grid Voltage | 1630 | v |
| Peak RF Plate Voltage | 11800 | v |
| DC Plate Current | 20.5 | A |
| DC Grid Current | 3.5 | A |
| RF Load Resistance | 320 | ohms |
| Driving Power, approximate | 5.7 | kW |
| Power Output, approximate | 220 | kW |

| Typical Operation, Cathode-Drive | ML-7560 | | |
|---|---|---|---|
| DC Plate Voltage | 12000 | 12000 | V |
| DC Grid Voltage | −800 | −800 | V |
| Peak RF Grid Voltage | 1350 | 1200 | v |
| Peak RF Plate Voltage | 10600 | 10400 | v |
| DC Plate Current | 13.5 | 11.5 | A |
| DC Grid Current | 3.5 | 2 | A |
| RF Load Resistance | 490 | 550 | ohms |
| Driving Power, approximate | 20 | 15 | kW |
| Power Output, approximate ‡ | 145 | 120 | kW |

### RF Power Amplifier and Oscillator Class C Telegraphy

Key-down conditions per tube without amplitude modulation§

| Maximum Ratings, Absolute Values | ML-7560 | ML-8317 | |
|---|---|---|---|
| DC Plate Voltage | 20000 | 20000 | V |
| DC Grid Voltage | −1500 | −1500 | V |
| DC Plate Current | 35 | 20 | A |
| DC Grid Current | 4.0 | 3 | A |
| Plate Dissipation | 175 | 60 | kW |

| Typical Operation | ML-7560 | | |
|---|---|---|---|
| DC Plate Voltage | 20000 | 20000 | V |
| DC Grid Voltage | −1000 | −1000 | V |
| Peak RF Grid Voltage | 1680 | 1320 | v |
| Peak RF Plate Voltage | 17400 | 18000 | v |
| DC Plate Current | 29 | 11 | A |
| DC Grid Current | 3.4 | 1.3 | A |
| RF Load Resistance | 330 | 900 | ohms |
| Driving Power, approximate | 6 | 2 | kW |
| Power Output, approximate | 440 | 175 | kW |

### Plate-Pulsed RF Power Amplifier and Oscillator Class C

| Maximum Ratings, Absolute Values | ML-7560 | ML-8317 | |
|---|---|---|---|
| Peak Plate Pulse Supply Voltage | 40 | 40 | kv |
| DC Grid Voltage | −3500 | −3500 | V |
| Peak Cathode Current | 550 | 550 | a |
| Grid Dissipation | 3000 | 3000 | W |
| Plate Dissipation | 175 | 60 | kW |
| Pulse Duration# | 500 | 500 | μs |
| Duty Factor# | .10 | .05 | |

| Typical Operation | | |
|---|---|---|
| Peak Plate Pulse Supply Voltage | 40 | kv |
| DC Grid Voltage | —1400 | V |
| Peak RF Grid Voltage | 3000 | v |
| Peak RF Plate Voltage | 34 | kv |
| Peak Plate Current from Pulse Supply | 100 | a |
| Peak Rectified Grid Current | 16 | a |
| RF Load Resistance | 200 | ohms |
| Driving Power during Pulse, approximate | 45 | kw |
| Power Output during Pulse, approximate | 3.0 | Mw |

| Typical Operation, Cathode-Drive | | |
|---|---|---|
| Peak Plate Pulse Supply Voltage | 40 | kv |
| DC Grid Voltage | —1400 | V |
| Peak RF Grid Voltage | 3000 | v |
| Peak RF Plate Voltage | 34 | kv |
| Peak Plate Current from Pulse Supply | 100 | a |
| Peak Rectified Grid Current | 16 | a |
| RF Load Resistance | 210 | ohms |
| Driving Power during Pulse, approximate | 310 | kw |
| Power Output during Pulse, approximate ‡ | 3.2 | Mw |

## Pulse Modulator or Pulse Amplifier

| Maximum Ratings, Absolute Values | ML-7560 | ML-8317 | |
|---|---|---|---|
| DC Plate Voltage | 50 | 50 | kV |
| Peak Plate Voltage | 55 | 55 | kv |
| DC Grid Voltage | —3500 | —3500 | V |
| Pulse Cathode Current | 550 | 550 | a |
| Grid Dissipation | 3000 | 3000 | W |
| Plate Dissipation | 175 | 60 | kW |
| Pulse Duration# | 1000 | 1000 | μs |
| Duty Factor# | .01 | .01 | |

| Typical Operation | | |
|---|---|---|
| DC Plate Voltage | 50 | kV |
| DC Grid Voltage | —1800 | V |
| Pulse Positive Grid Voltage | 1600 | v |
| Pulse Plate Current | 350 | a |
| Pulse Grid Current | 80 | a |
| Pulse Driving Power | 275 | kw |
| Pulse Power Output | 15.7 | Mw |
| Plate Output Voltage | 45 | kv |

▲Averaged over any audio-frequency cycle of sine-wave form.

†With peak-envelope to average power ratio of approximately 10.

‡Includes power transferred from driver stage.

§Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

#For applications requiring longer pulse duration or higher duty factors, consult the Machlett Engineering Department.

**WARNING:** Operation of this tube may produce x-rays. Adequate rayproof shielding must therefore be provided in the equipment.

## MAXIMUM FREQUENCY RATINGS

Maximum ratings apply up to 30 Mc except as noted. These tubes may be operated at higher frequencies provided the maximum value of plate voltage is reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at the higher frequencies.

| Frequency in Megacycles | 30 | 70 | 110 |
|---|---|---|---|
| Percent Maximum Rated Plate Voltage | 100 | 80 | 60 |

## TUBE PROTECTION

The handling of very high power requires particular attention to the removal of power from tubes during fault conditions (initiated by tube or circuit instabilities) since the larger amount of energy involved can cause tube damage if not properly controlled. The tube must, therefore, be protected by limiting the time elapsed from inception of a fault condition to diverting the energy from the tube, as well as the amount of energy expended in the tube during this interval.

In addition to the normal circuit breakers and overload relays, it is necessary that a fast-acting electronic protective device (crowbar) or equivalent be used. This device will in most cases be a triggered gaseous device connected across the output of the plate supply filter, if used, to dissipate the filter-circuit energy as well as the rectifier output. The complete energy source must be shorted out as quickly as possible after the inception of a "fault", and in most cases the time interval should not be allowed to exceed approximately ten microseconds. For some basic elecronic-crowbar fault-protection circuit considerations, as well as test of the effectiveness of a protection device, refer to the references listed.

A nominal value of resistance must be placed in the plate lead of the tube being protected in order to be assured that the impedance of this tube under a flash arc condition is greater than that of the crowbar device when the latter is triggered. Critical damping is required for the crowbar discharge circuit. It is also recommended that a minimum of five to ten ohms resistance be connected in series with each rectifier tube in order to limit surge currents.

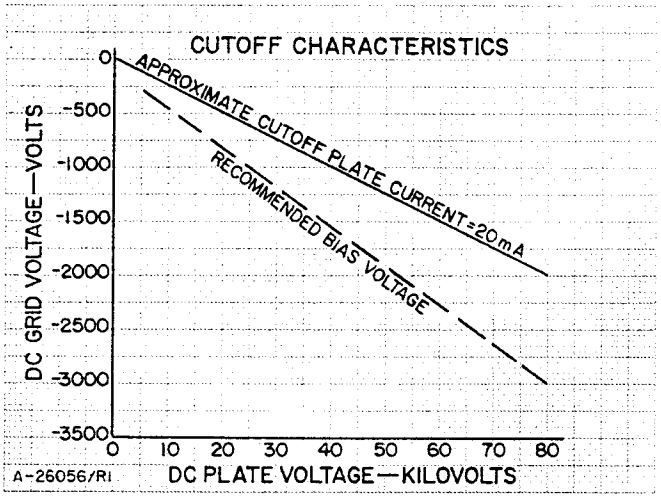
In circuits where high transient voltages may be developed due to a shorted load or other fault, special precautions are necessary to keep these excessive voltages from appearing at the tube electrodes.

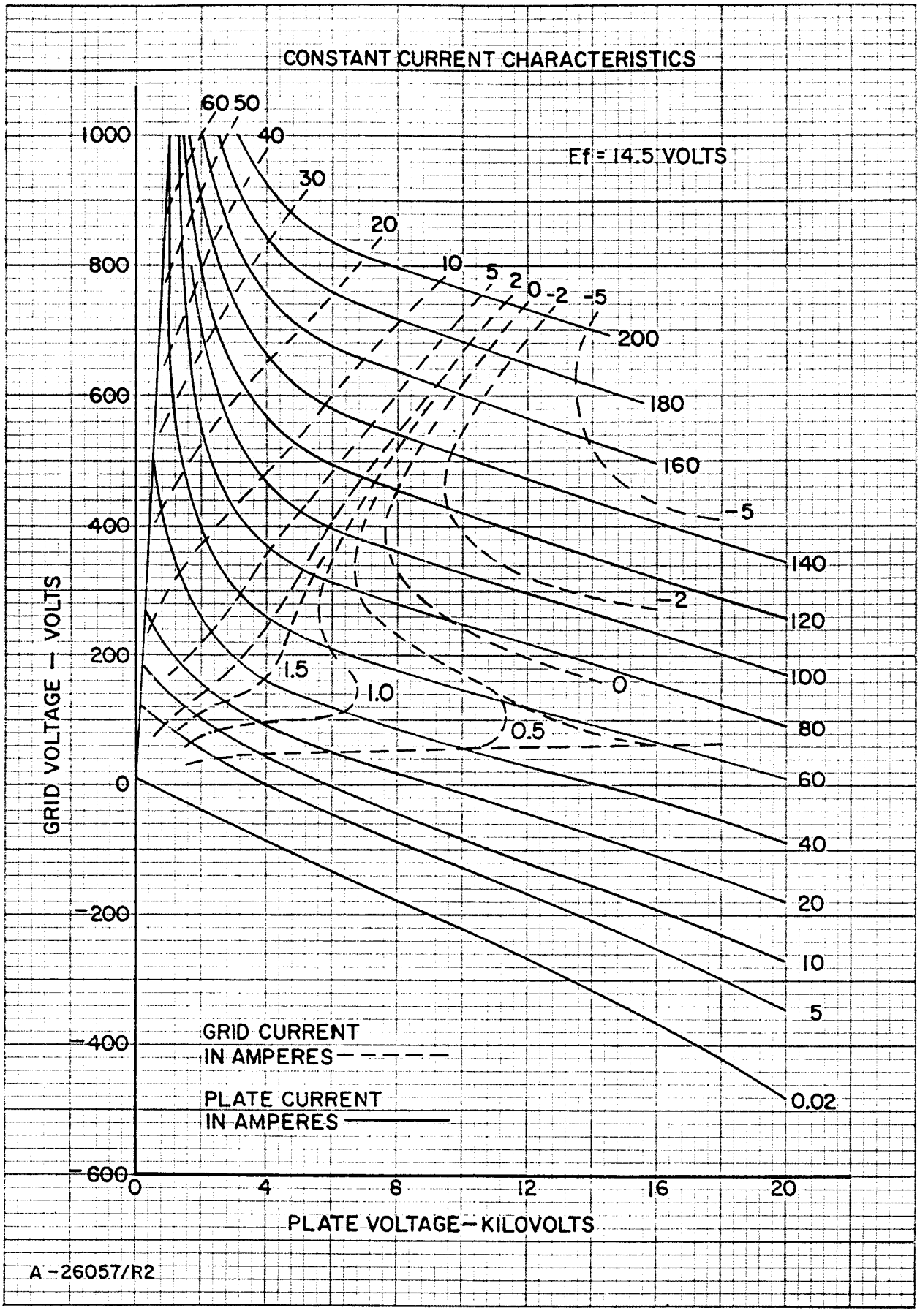
References:

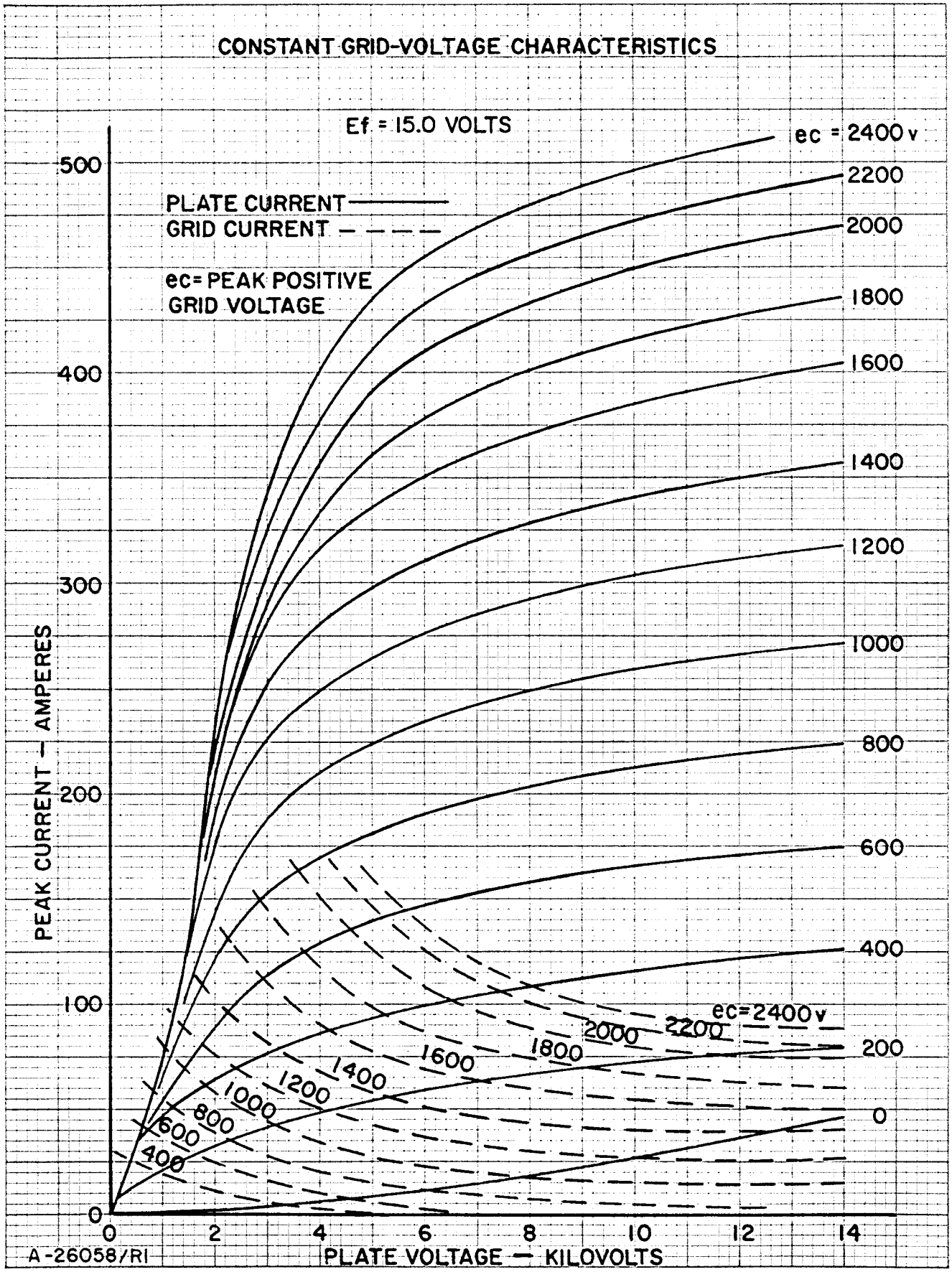
1. W. N. Parker and M. V. Hoover, "Gas Tubes Protect High Power Transmitters", *Electronics, 29,* 144, January 1956.
2. H. D. Doolittle, "High Power Hydrogen Thyratrons", *Cathode Press, 1, 6,* 1954.

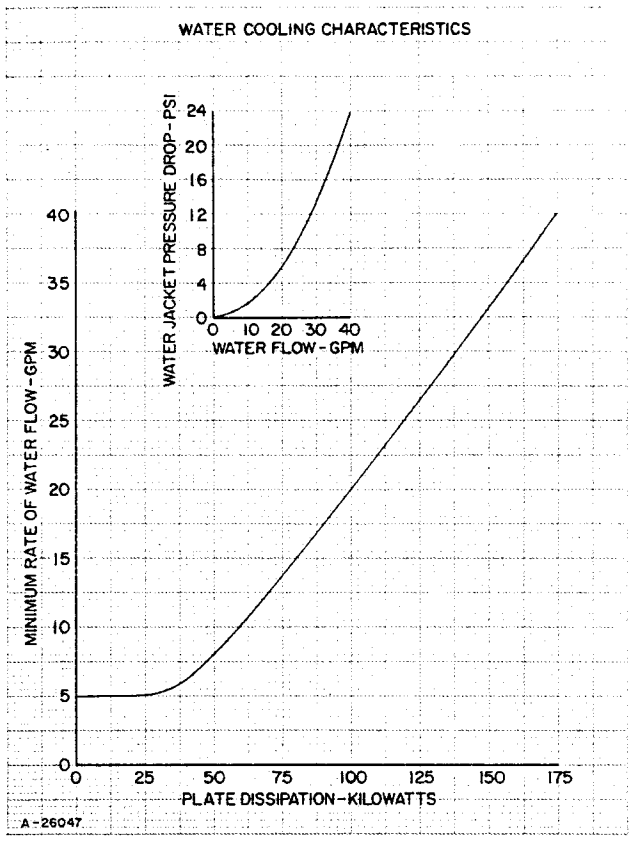
## MAINTENANCE

The anode cooling fins of the ML-8317 must be kept free from films of foreign materials, which will impair heat flow. To keep fins clean, it is suggested that ultrasonic cleaning or wire-brushing of the anode cooling surfaces be performed on a routine maintenance basis.

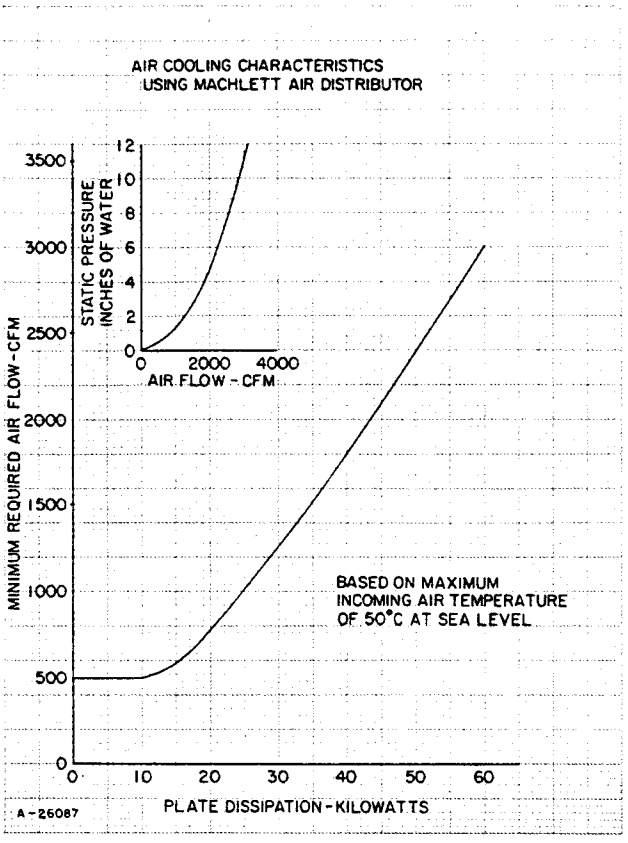



CONSTANT CURRENT CHARACTERISTICS
Ef = 14.5 VOLTS
60 50
40
30
20
10
5
2
0
-2
-5
200
180
160
-5
140
-2
120
100
0
80
1.5
1.0
0.5
60
40
20
10
5
0.02
1000
800
600
400
200
0
-200
-400
-600
GRID VOLTAGE — VOLTS
GRID CURRENT IN AMPERES - - - -
PLATE CURRENT IN AMPERES ——
0
4
8
12
16
20
PLATE VOLTAGE—KILOVOLTS
A-26057/R2

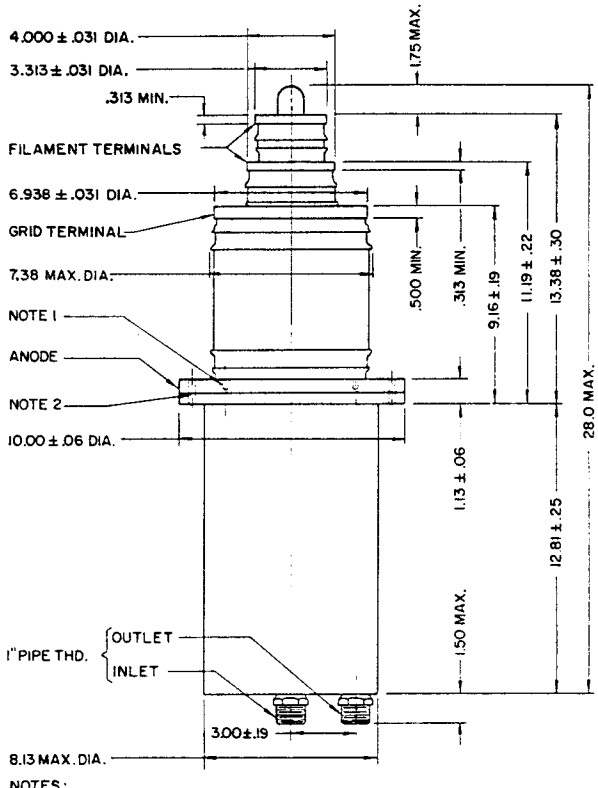

CONSTANT GRID-VOLTAGE CHARACTERISTICS
Ef = 15.0 VOLTS
PLATE CURRENT
GRID CURRENT
ec= PEAK POSITIVE GRID VOLTAGE
ec = 2400 v
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
PEAK CURRENT — AMPERES
PLATE VOLTAGE — KILOVOLTS
A-26058/RI




ML-7560




ML-8317




NOTES:
1. FOUR HOLES, $\frac{5}{16}$ DEEP, $\frac{1}{4}$ - 20 TAP, EQUALLY SPACED ON 8.19 ± .03 B.C., FOR LIFTING.
2. FOUR THROUGH HOLES .290 DIA. ON 9.16 ± .03 B.C. FOR MOUNTING, LOCATED APPROX. 45° FROM TAPPED HOLES.

ALL DIMENSIONS IN INCHES.

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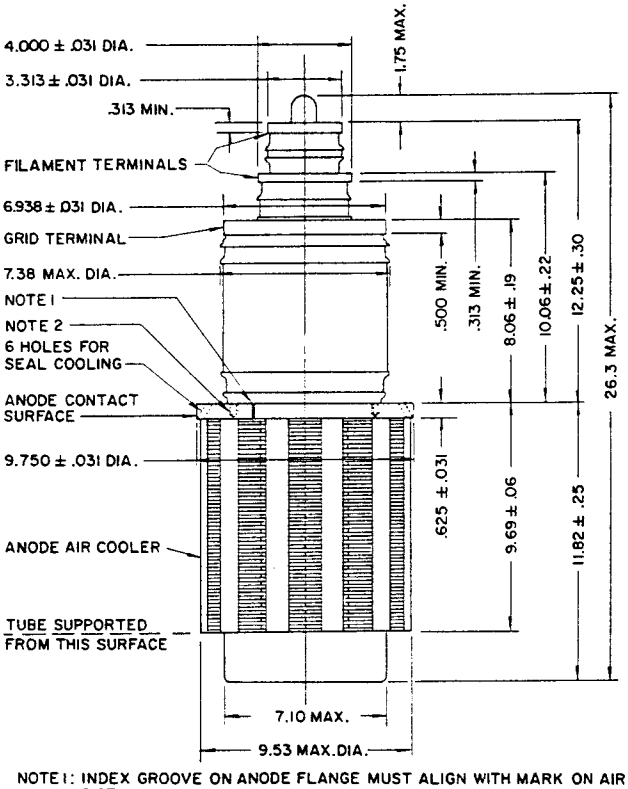


NOTE 1: INDEX GROOVE ON ANODE FLANGE MUST ALIGN WITH MARK ON AIR DISTRIBUTOR TO ASSURE PROPER LOCATION OF SEAL COOLING HOLES.

NOTE 2: 4 - $\frac{1}{4}$ - 20 TAPPED HOLES EQUALLY SPACED ON A 8.19 ± .03 DIA. B.C. FOR LIFTING.

ALL DIMENSIONS IN INCHES

ED-27363/R2

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